REMARKS

Claims 1-25 were pending in the above-captioned patent application at the time of the Office Action. The Office Action rejects claims 1-14, 17-20, and 23-25. Claims 15, 16, 21, and 22 are objected to but would be allowable if rewritten in independent form. In response to the objections and rejections, applicant amends claims 1, 4, 5, 7, 11-13, 18, 19, and 23. New claims 26-42 have also been added. Allowance of pending claims 1-42 is respectfully requested in view of the above-recited amendments and the arguments set forth below.

New Claims

New claims 26-30 are added in response to the objection to claims 15 and 16. New claims 31-33 are added in response to the objection to claims 21 and 22. New claims 34 and 35 depend on amended claim 1 and are believed allowable for the reasons set forth below with respect to the allowability of amended claim 1. New claim 36 includes substantially the same limitations as amended claim 1 except for the omission of the sweep stream element. New claims 37-42 depend directly or indirectly on new claim 36. New claims 36-42 are believed allowable for the reasons set forth below with respect to the allowability of amended claim 1.

Rejections Under 35 U.S.C. §112

Claims 4, 5, and 7 have been rejected under 35 U.S.C. §112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter regarded as the invention. The amendments to claims 4, 5 and 7 set forth above overcome the instant ground of rejection by correcting the language at issue.

Rejections Under 35 U.S.C. §102

Claims 1, 4, 7, 9-13, 17, 19, and 23 have been rejected under 35 U.S.C. §102(b) as being anticipated by U.S. Patent 3,244,763 to Cahn. It is respectfully submitted that after the above-recited amendments to independent claims 1, 19 and 23, all rejected claims traverse the instant ground of rejection.

The following limitations have been added to each independent claim 1, 19 and 23 by

amendment:

> **The solid membrane is selective and is constructed from one or more compounds providing greater permeation selectivity for the feed sulfur species than the feed liquid hydrocarbon.**

It is respectfully submitted that Cahn no longer anticipates the claims at issue because Cahn lacks disclosure of the above-recited claim limitations. "... [A]nticipation requires that all of the elements and limitations of the claim are found within a single prior art reference." *Scripps Clinic & Research Foundation v. Genentech, Inc.*, 927 F.2d 1565, 18 USPQ2d 1001, 18 USPQ2d 1896 (Fed. Cir. 1991).

Cahn and applicant's claimed invention both relate to semipermeable membrane extraction. In general terms, membrane extraction requires positioning a membrane having two opposing sides in a space. The membrane separates the space into two distinct volumes with the first side of the membrane interfacing the first volume and the second side of the membrane interfacing the second volume. The membrane has a thickness which extends between the first and second sides of the membrane and effectively functions as a medium through which matter is transported from one volume to the other.

Membrane extraction proceeds by placing a mixture containing a component to be extracted in the first volume such that the mixture (termed a feed stream by applicant) contacts the first side of the membrane. The component to be extracted is then transported out of the first volume, through the membrane, and into the second volume by any number of transport mechanisms, while the remainder of the feed stream remains in the first volume. An extractant (termed a sweep stream by applicant) is optionally placed in the second volume in contact with the second side of the membrane to receive the extracted component once it is transported through the membrane.

The membrane is immiscible in the feed stream and sweep stream and is essentially at steady-state both chemically and physically throughout the membrane extraction process, or at least for relatively long periods of time during the process. Accordingly, membrane extraction is readily adaptable to continuous operation. It may be necessary to replace or

regenerate the membrane over time, but only after extended use, in the analogous manner that it would be necessary to replace or regenerate a water treatment filter medium, such as a sand filter bed, after extended use due to sediment build-up.

The term "semipermeable" refers to the selectivity of a membrane to different chemical components. Thus, the terms "semipermeable" and "selective" are synonymous with respect to membranes. A semipermeable membrane selectively promotes the transport of certain components through the membrane, while simultaneously selectively inhibiting the transport of other components through the membrane. The selectivity of the semipermeable membrane is generally a complex function of the chemistry and physics of the material which makes up the semipermeable membrane and its relation to the chemistry and physics of the components of the feed stream. Semipermeable membrane extraction requires interaction on a chemical and physical level between the material of the semipermeable membrane and the components of the feed stream. The nature of the interaction between the membrane material and a given component of the feed stream is determinative of the degree of permeation selectively of the semipermeable membrane for that component of the feed stream. Stated alternatively, the nature of the interaction between the membrane material and a given component is determinative of whether the membrane material promotes or inhibits transport of that component through the semipermeable membrane.

Semipermeable membranes are known to exist in either a solid state or a liquid state. As such, semipermeable membranes are characterized as either solid membranes or liquid membranes. Solid membranes have a fixed static structure, at least on a macroscopic level. Solid membranes are typically configured as two-sided, stationary sheets, rolls or tubes of material, which define two fixed volumes on opposite sides of the membrane. The feed stream resides in the first volume and the extracted component is transported through the solid membrane to the second volume. In a solid membrane, the structural material, from which the solid membrane is constructed and which provides the solid membrane its fixed structure, and the selective material, which interacts with the components of the feed stream and which determines the permeation selectivity of the membrane, are one in the same material.

The particular transport mechanism, by which the extracted component is transported from the feed stream through the solid membrane, is specific to the actual solid membrane material. For example, in accordance with a solid-fluid molecular solubility transport mechanism, transport of the extracted component through the solid membrane is effected by individual molecules of the extracted component traversing the interstitial void spaces between the molecules or macromolecules of the solid membrane material from one side of the membrane to the other.

Liquid membranes by themselves lack the fixed structure of solid membranes, but nevertheless emulate a two-sided structure by employing one of a number of alternate techniques. For example, a dynamic liquid membrane, termed an emulsion liquid membrane, emulates a two-sided structure by dispersing a liquid emulsion within a liquid feed stream. The emulsion comprises a selective material in a liquid state, which is the liquid membrane, and an extractant in a liquid state, which is analogous to the sweep stream. The extractant is emulsified within and enveloped by the liquid membrane to prevent contact between the extractant and the feed stream. The liquid membrane is immiscible in both the feed stream and the extractant, but is selective for components in the feed stream. The dynamic interface between the liquid membrane and the feed stream is the first side of the membrane and the dynamic interface between the liquid membrane and the extractant is the second side of the membrane. The extracted component passes through the liquid membrane material by a liquid-liquid diffusion transport mechanism.

An alternate liquid membrane, which more closely mimics the stationary structure of a solid membrane, is termed a supported liquid membrane. The supported liquid membrane is employed in cooperation with a fixed solid support. The solid support is fabricated by configuring a solid, porous material in a fixed structure which may have a substantially identical external configuration to that of a solid membrane. The pores of the solid support provide open pathways for the feed stream through the solid support. However, the structural material which integrally forms the solid support is typically not interactive with the components of the feed stream. A non-interactive solid support neither selectively promotes nor inhibits passage of specific components of the feed stream through the solid support, but essentially enables the passage of all components of the feed stream through

the pores equally.

Although the solid support has the same outward configuration as the solid membrane, permeation selectivity is typically provided by a liquid membrane rather than the solid support, which has the sole function of supporting the liquid membrane. Construction of the liquid membrane is effected by pretreatment of the solid support, wherein the solid support is contacted with a desired selective liquid, which is absorbed into and retained by the pores of the solid support to form the liquid membrane. Although the pores of the solid support are open to the feed stream, the feed stream cannot pass through the pores without encountering the liquid membrane. Thus, the transport mechanism for the extracted component through the supported liquid membrane and through the emulsion liquid membrane recited above is substantially the same, i.e., liquid-liquid diffusion.

The discussion of semipermeable membrane extraction above relates directly to the present issue of patentability. Specifically, Cahn teaches a membrane extraction process and apparatus, which utilize a supported selective liquid membrane substantially as described above. The selective liquid membrane of Cahn is termed a selective solvent and the solid support is termed a porous, absorbent barrier. See col. 2, lines 21-28. As shown in Figure 1 of Cahn and described at col.2, lines 63-72 and col. 3, lines 10-19, the selective solvent C (or selective liquid membrane) is absorbed into the pores 2 of the absorbent barrier 1 (or solid support) by soaking the absorbent barrier 1 with the selective solvent C. When one side of the absorbent barrier 1 is subsequently contacted by a feed stream (termed a mixture of A and B by Cahn), the desired component A is extracted from the mixture of A and B into the selective solvent C, which fills the pores of the absorbent barrier 1. The selective solvent-filled pores provide a diffusion path to transport the component A to the opposite side of the absorbent barrier 1 where a sweep stream (termed a re-extraction fluid by Cahn) leaches the component A from the selective solvent C into the re-extraction fluid.

In contrast to Cahn, all of applicant's pending claims with the exception of claims 26-33 recite a membrane extraction process, which utilizes a selective solid membrane. Specifically, the selectivity of the solid membrane is provided by one or more compounds

from which the solid membrane is constructed. Although a facilitated transport liquid may optionally be adsorbed or absorbed onto the solid membrane to facilitate transport of the extracted component through the solid membrane, the solid membrane must be selective for the component to be extracted even in the absence of a facilitated transport liquid. The teaching of a selective solid membrane for membrane extraction as claimed by applicant is lacking from Cahn because Cahn ascribes no selective characteristics to the solid absorbent barrier. See Cahn at col. 5, lines 36-39. Cahn only attributes selective characteristics to the selective solvent, which is liquid rather than solid. Accordingly, the §102(b) rejection is overcome with respect to all rejected claims.

It is further submitted that Cahn does not, in the alternative, render applicant's pending claims unpatentably obvious under §103. At col. 1, lines 40-46, Cahn generally describes the transport mechanism for permeation of a non-porous membrane in a separation process. The transport mechanism for permeation of non-porous membranes described by Cahn is essentially the same as the solid-fluid molecular solubility transport mechanism described above. Although applicant's claims are not limited to a particular transport mechanism, page 10, lines 30-32, of the application indicates that applicant's claimed selective solid membrane is likewise capable of operation in accordance with the solid-fluid molecular solubility transport mechanism, thereby behaving as a non-porous membrane.

At col. 2, lines 4-10, Cahn defines non-porous and semipermeable as synonymous terms for the characterization of a membrane and states that the utility of non-porous membranes for membrane extraction is limited to very specific situations:

> "In the case of non-porous membranes, i.e. by using semi-permeable membranes, it is usually difficult to find a material for the membrane construction which will effect the desired separation. **Only in very specific instances can a suitable resin, parchment, rubber or the like be found** [emphasis added] which will exhibit this phenomenon of 'semi-permeability.'"

Cahn recognizes that, in practice, it is usually difficult to identify an appropriate selective solid material for construction of a semipermeable solid membrane, which can successfully perform a specific membrane extraction. For most specific membrane extraction applications, there are no known selective solid membranes, according to Cahn, which

work. Accordingly, Cahn turns to selective solvents as supported liquid membranes to successfully perform the specific semipermeable membrane extractions described at col. 3, lines 33-64 and at col. 4, line 65 through col. 5, line 20. At col. 4, lines 68-71, Cahn expressly discloses use of a caustic solution as a supported liquid membrane to extract mercaptans from a hydrocarbon stream. As such, Cahn teaches away from using a selective solid membrane for applicant's claimed membrane extraction application, i.e., extraction of sulfur species from a hydrocarbon feed stream.

A reference teaches away from a claimed invention if the reference suggests that the line of development flowing from the disclosure of the reference would not likely produce the result sought by the applicant. *United States v. Adams*, 383 U.S. 39, 52, 148 USPQ 479, 484 (1966). Stated another way, a reference teaches away from a claimed invention if a person of ordinary skill in the art would be led in a direction divergent from the path taken by the applicant after reading the reference. *In re Gurley*, 27 F.3d 551, 31 USPQ2d 1130 (Fed. Cir. 1994).

In *Gurley*, the applicant claimed an epoxy resin for use as a printed circuit material. The claims were rejected as obvious over a prior art reference which disclosed a polyester-imide resin for the same use as claimed by the applicant. The prior art reference also stated that the use of epoxy resins for printed circuit materials was known, but epoxy resins were believed to be inferior to polyester-imide resins for this use. The applicant argued that the teaching of the prior art reference was insufficient to support the obviousness rejection because its statements regarding the inferiority of epoxy resins teach away from applicant's claimed invention. On appeal, the court affirmed the obviousness rejection, explaining, "A known or obvious composition does not become patentable simply because it has been described as somewhat inferior to some other product for the same use." A determinative factor in the court's obviousness finding was that the prior art reference teaches that epoxy resins had been in fact used for applicant's same specific purpose, albeit with somewhat inferior results.

The present facts are distinguishable from *Gurley*. The Cahn prior art reference presently at issue states that solid semipermeable membranes are known to have utility for

membrane extraction, but their utility is limited to specific narrow applications. However, no specific applications are disclosed by Cahn as a follow-up to this statement. Cahn instead discloses the use of supported liquid membranes for several specific applications including the extraction of mercaptans from a hydrocarbon. A fair characterization of Cahn's teaching is that a solid semipermeable membrane may work for some membrane extraction applications, but is unlikely to work for most. Cahn is silent whether or not a solid semipermeable membrane would work for applicant's specific claimed membrane extraction application, which extracts sulfur species from a hydrocarbon stream.

From this teaching, one of ordinary skill in the art would conclude the following: Cahn suggests that a solid semipermeable membrane will not likely work for applicant's specific claimed membrane extraction application because specific solid materials, which will work as semipermeable solid membranes, are not known for the majority of specific solid membrane extraction applications. Accordingly, Cahn teaches away from applicant's claimed invention and correspondingly fails to support an obviousness rejection of applicant's claims.

Rejections Under 35 U.S.C. §103

Claims 2, 3, 5, 6, 8, and 18 have been rejected under 35 U.S.C. §103(a) as being unpatentably obvious over U.S. Patent 3,244,763 to Cahn. It is respectfully submitted that the rejected claims traverse the instant ground of rejection for substantially the same reasons as set forth above.

Claims 14 and 20 have been rejected under 35 U.S.C. §103(a) as being unpatentably obvious over U.S. Patent 3,244,763 to Cahn in view of U.S. Patent 4,417,986 to Connaught et al. It is respectfully submitted that the rejected claims traverse the instant ground of rejection for substantially the same reasons as set forth above and because Connaught et al. fails to supplement the teaching of Cahn with respect to selective solid membranes. Connaught et al. only teaches the utility of amines and alcohols as agents for enhancing the solubility of mercaptans in a caustic solution, which is a known selective solvent for mercaptans. Such teaching does not suggest that an amine or alcohol can enhance the performance of a solid membrane because selective solid membranes and

selective liquid membranes typically employ different transport mechanisms. Accordingly, an agent which enhances the solubility of sulfur in a selective liquid membrane would not necessarily be expected to enhance the selectivity of a solid membrane for sulfur.

Claims 24 and 25 have been rejected under 35 U.S.C. §103(a) as being unpatentably obvious over U.S. Patent 3,244,763 to Cahn in view of U.S. Patent 4,978,439 to Carnell et al. It is respectfully submitted that the rejected claims traverse the instant ground of rejection for substantially the same reasons as set forth above and because Carnell et al.fails to supplement the teaching of Cahn with respect to selective solid membranes. Carnell et al. discloses separation of sulfur species from a hydrocarbon feed stream using a membrane at col. 2, lines 6-12 and lines 41-53, and at col. 3, lines 10-18. However, Carnell et al. only uses the general term "membrane separation" and does not specify whether the applicable membrane is a liquid membrane or a solid membrane as claimed by applicant. The general disclosure of membrane separation by Carnell et al. is insufficient to render the claimed invention obvious, when the reference with which Carnell et al. is combined, i.e., Cahn, only suggests the use of selective liquid membranes for the application of Carnell et al. and teaches away from the use of selective solid membranes in the context of Carnell et al.

The remaining prior art references made of record and not relied upon have been considered by applicant, but are not deemed sufficient to render the instant pending claims unpatentable.

Conclusion

In conclusion, applicant respectfully asserts that all pending claims 1-42 in the instant patent application are allowable for the reasons set forth above. Accordingly, an early notice of allowance is respectfully solicited. The Examiner is requested to call the undersigned at (858) 272-8705 for any reason that would advance the instant application to issue.

Respectfully submitted,

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